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ABSTRACT

This nuclear chemistry module includes topics on atomic structure, instability of the nucleus, detection strengths and the uses of radioactive particles. Laboratory work stresses proper use of equipment and safe handling of radioactive materials. Students with a strong mathematics background may consider this course as advanced work in chemistry. A reference list of six books is given and twelve performance objectives are stated. The course outline presents seven topics: (1) Units; (2) Nuclear Composition; (3) Nuclear Activity; (4) Radiation; (5) Nuclear Rearrangement; (6) Application; and (7) Safety. Experiments, including several from the United States Atomic Energy Commission, are indicated. Demonstrations, projects, reports, field trips, and suggested guest speakers are incorporated into the program. References include films and readings. A master sheet coordinates the entire curriculum. (Author/EB)

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AUTHORIZED COURSE OF INSTRUCTION FOR THE QUINMESTER PROGRAM

NUCLEAR CHEMISTRY

5316.62

SCIENCE

(Experimental)

DADE COUNTY PUBLIC SCHOOLS

DIVISION OF INSTRUCTION • 1971

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Written by Russell R. Williams
for the
DIVISION OF INSTRUCTION
Dade County Public Schools
Miami, Florida
1972

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NUCLEAR CHEMISTRY

COURSE DESCRIPTION

Topics to be studied in this course include the atomic structure, instability of the nucleus, detection of, strengths of and the uses of radioactive particles. Laboratory work will stress proper use of equipment along with safe handling of radioactive materials.

ENROLLMENT GUIDELINES

It is recommended that students with a strong mathematics background consider this course as advanced work in chemistry (2nd year).

TEXTBOOK REFERENCE LIST

* 1. Choppin, Gregory R. and Jaffe, Bernard. Chemistry. Morristown, New Jersey: Silver Burdett Company, 1965.

2. Quagliano, James V. Chemistry. 2nd ed. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1964.

3. Gamow, George and Cleveland, John M. Physics. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1961.

4. Overman, R. T. Basic Concepts of Nuclear Chemistry. (paperback) New York: Reinhold, 1963.

5. Houston, Walter Scott. Frontiers of Nuclear Physics. (paperback) Middletown, Connecticut: American Education Publications, 1963.

6. United States Atomic Energy Commission. Radioisotopes Experiments for High School Curriculum. Chicago, Illinois: Nuclear Chicago Corporation, 1966.

* State adopted.

PERFORMANCE OBJECTIVES

The student will:

1. Use scientific terms and units in all nuclear chemistry problems.

2. In a discussion of the nucleus, describe in detail its basic make-up, binding energy and mass deficiency.

3. Describe in detail the various types of radiation decay products and conditions that lead to the emission of such particles.

4. Given several radioactive isotopes, operate the counting equipment in order to identify substances by the use of half-life determination.

5. Working with proper counting equipment, specify the radiation coming from surrounding environment (background).

6. In a laboratory situation, describe in detail proper use of radiation detection equipment.

7. Given a nuclide chart and various types of isotopes, identify the characteristics of the isotopes, decay products, energies of decay products and half-life.

8. Explain rearrangement possibilities in nuclear reactions, how they happen and what uses the rearrangements may serve.

9. When working radioactive substances in a chemistry laboratory, the student will follow completely all safety precautions as prescribed by AEC laboratory manual.

10. Describe in detail uses of radiation materials in producing weapons, medicines, energy, synthetics and analytical tools.

11. In a laboratory experience, demonstrate how radiation is used to trace many chemical analyses.

12. In a laboratory situation, identify the procedure of dilution analysis and fluid volumes determination.

COURSE OUTLINE

I. Units

A. Energy

B. Density

C. Dosage

1. Roentgen

2. Rad

D. Statistical

II. Nuclear Composition

A. Particles

B. N-P ratio

C. Binding energy

D. Mass defect

III. Nuclear Activity

A. Decay

1. Alpha particles

2. Beta particles

3. Positron particles

4. Gamma emission

B. Measurement

1. Duration

2. Strength

IV. Radiation

A. Background

B. Detection

COURSE OUTLINE (Continued)

1. Gas type

a. Gold leaf electroscope
b. Dosimeter
c. G-M pulse counter

2. Scintillation type

3. Cloud chamber

4. Emulsion

C. Safety

V. Nuclear Rearrangement

A. Natural

B. Synthetic

1. Atom smashers

2. Fission

3. Fusion

C. Fallout

VI. Application

A. Destructive

1. Weapons

2. Medical

B. Constructive

1. Energy

2. Synthesis

C. Analysis

1. Detection devices

2. Isotopic dilutions

COURSE OUTLINE (Continued)

3. Age-dating

4. Chemical analysis

5. Biological analysis

VII. Safety

A. AEC laboratory safety rules

B. Pipetting

1. Transfer pipets

2. Serological pipets

3. Micro pipets

4. Errors

5. Dangerous liquids

C. Preparing samples for counting

D. Preparing samples for filtering

EXPERIMENTS

Geffner, Saul L. and Lauren, Paul M. Experimental Chemistry. 2nd ed. New York: Amsco School Publications, Inc., 1968.

1. Radioactivity (pp. 215-222)

United States Atomic Energy Commission. Radioisotopes Experiment for the Chemistry Curriculum. Chicago, Illinois: Nuclear-Chicago Corporation, 1960.

2. Characteristics of G-M Tube (Experiment G-1)
3. Statistics in Counting (Experiment G-2)
4. Determination of Half-life of Simple Radiodecay (Experiment G-3)

EXPERIMENTS (Continued)

Oak Ridge Institute of Nuclear Studies. Mobile Radioisotope Laboratory Manual. Oak Ridge, Tennessee: (Revised 1962 Thomas Stone)

5. G-M Counters and Scaling Systems (Experiment 1)
6. Scattering, Absorption and Range of Beta Particles (Experiment 2)
7. Identifying an Unknown Isotope (Experiment 4)
8. Electrometer and Pocket Dosimeter (Experiment 5)
9. Isotope Dilution (Experiment 7)

DEMONSTRATIONS

Alyea, Hubert N. and Dutton, Frederic B. Tested Demonstrations in Chemistry. 6th Edition. Easton, Pennsylvania: Journal of Chemical Education Society, 1965.

1. Becquerel's Discovery (p. 21)
2. Electroscope (p. 21)
3. Roentgen Rays (p. 21)
4. Cloud Chamber (p. 21)
5. Absorption of Beta Rays (p. 21)
6. Thickness Measurements, by Beta Ray Count (p. 21)
7. Scattering of Beta Rays (p. 22)
8. Gamma Ray: Inverse Square Law (p.22)
9. Absorption of Gamma Rays (p. 22)
10. Auto-Radiography (p. 89)
11. Spintheriscope (pp. 89-90)
12. Radioisotopes in the Air (p. 131)

PROJECTS

1. Simple radiation detector-electronic
2. Devise method to separate radioactive and nonradioactive atoms of same element
3. Construct a model of a mass spectrometer
4. Set-up studies to analyze safety procedures in your laboratory
5. Methods used to analyze particles emitted by the atom

REPORTS

1. Carbon Dating and Other Dating Methods
2. Shipping Procedures for Radioactive Samples
3. Neutron-Activation Analysis and Its Uses
4. Gaseous Diffusion Separation for U^{238} and U^{235}
5. Nuclear Power to Generate Electricity
6. Terms Used in Nuclear Chemistry and Their Origin
7. The Many Various Particles Enitted From the Aton

FIELD TRIPS

1. Division of Nuclear Medicine
   North Wing #1
   Jackson Memorial Hospital
   Miami, Florida
2. Applied Research Lab
   Hialeah, Florida

GUEST SPEAKERS

1. Gaylord King
   Division of Nuclear Medicine
   Jackson Memorial Hospital
   Miami, Florida

FILMS - DADE COUNTY 16 mm FILMS AVAILABLE FROM DADE COUNTY AUDIOVISUAL CENTER

1. Atoms and Biological Science
   AV #1-03550, 12', B/W

2. Atom Goes to Sea
   AV #1-01924, 12', B/W

3. Atom Smashers
   AV #1-01922, 12', B/W

4. Atom Smashers
   AV #1-01923, 12', B/W

5. Atomic Energy
   AV #1-01940, 10', B/W

6. Atomic Energy: Inside Atom
   AV #1-10786, 14', C

7. Atomic Power
   AV #1-10918, 19', B/W

8. Atomic Research
   AV #1-10788, 12', B/W

9. Atomic Power
   AV #1-01943, 10', B/W

10. Nuclear Radiation: Detectors
    AV #1-10798, 15', C

11. Unlocking the Atom
    AV #1-10787, 10', B/W

RECOMMENDED READING (Students and Teachers)

1. Bagnall, K. W. Chemistry of Rare Radioelements. London: Butterworth Scientific Publication, 1957.

2. Gamow, George. Mr. Tompkins Explores the Atom. New York: Cambridge University Press, 1955.

3. Heisenberg, Werner. Philosophic Problems of Nuclear Science. (paperback) New York: Panthion Book, Inc., 1952.

4. Hughes, Donald. Neutron Story. (paperback) Garden City, New York: Doubleday and Company, Inc.

5. McKown, Robin. Fabulous Isotopes. (2nd ed) New York: Holiday House, Inc., 1962.

6. Moore, Walter J. Physical Chemistry. (3rd ed) Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1962.

MASTER SHEET--NUCLEAR CHEMISTRY

Objectives	Experiments	Textbook References	Films	Projects	Reports	Demonstrations	Speakers	Recommended Reading	Field Trips
1		1,4,6	7		1,6		1	6	
2		1,4	3,4,5,9	3,5	3,7	1,3,4,5		2	
3	1,2,3,6	1,4	3,4,9	5	1,7	1,3,4,5		2,5	
4	4,7	1							
5	1	1	10,11	1,5	3	12		3	
6	2,5,6,8	6	11		2	2,11	1		1,2
7		Nuclide Chart 1,4			6,7			1	
8	4,7	1,4			3		1	1	
9	1,2,4,6,7, 8,9	6		4	2		1		1,2
10	9	1	1,2	3	3,4,5	5,6,7,8	1	3,5	1,2
11	9	1	1,2	3	3,4,5	5,6,7,8	1	3,5	1,2
12	9	6			2		1		1